## The effect of axial unloading and partial reloading via donning the SkinSuit on the thoracolumbar spine

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Introduction: The human spine has evolved to support and facilitate movement in Earth's gravity. In microgravity, an absence of axial loading results in significant stature elongation, lower back pain and an increased risk of disc herniation, particularly of the thoracolumbar (T7-L3) region. Hyper-Buoyancy Flotation (HBF) a novel method of axial unloading, which we have demonstrated to induce stature elongation in excess of that associated with head down tilt. Skinsuit aims to provide partial (0.2G) axial loading (from shoulder to foot) in a graduated manner analogous to Earth's gravity. Thus, this study sought to determine the effect of unloading induced by 8h HBF with, and without partial axial reloading provided by the Mk VI SkinSuit upon stature and determine the proportion attributable to thoracolumbar intervertebral disc (IVD) elongation. Method: 9 healthy males (30±5yrs; 177.9±6.9cm; 74.9±8.1kg) gave written informed consent to participate in two randomised sessions of laying for 8h either with or without the SkinSuit on the HBF. Stature and subjective ratings of comfort and pain were recorded, PRE, DURING and POST. Intervertebral assessment (IVA) of the thoracic and lumbar spine was obtained from a Hologic Discovery-A QDR Series bone densitometry scan performed before and following each session to determine thoracolumbar (T7-L3) length and cumulative IVD height. Stature elongation, thoracolumbar elongation and IVD height were compared between conditions with a t-test and subjective data a Wilcoxon test. Results: Significant stature elongation was induced with, and without the SkinSuit following 8h on the HBF (1.7±0.5cm vs. 2.1±0.4cm), albeit lower with the SkinSuit. Similarly, thoracolumbar elongation obtained from the IVA at baseline (287.0±12.1mm) was lower when wearing the SkinSuit vs. control (289.9±8.5mm vs. 291.1±11.4mm) albeit non-significantly. Cumulative IVD height increments from baseline (58.1±7.1mm) recorded in the centre of the

disk were also lower with SkinSuit wear (61.0±7.5mm vs. 63.8±7.5mm), accounting for 70% of the difference in stature elongation reported between conditions. Median induced back pain was similar between conditions, however the interquartile range was considerably lower in SkinSuit [2.5 (2.0-3.0)] vs. control [2.5 (2.0-7.0)]. Discussion: Low level (0.2G) axial loading provided by the SkinSuit, partly attenuated HBF-induced stature and thoracolumbar elongation. IVD height was also partly attenuated with SkinSuit wear, accounting for the majority of total stature change between conditions. Maximal back pain was lower in those who wore the SkinSuit, possibly due to the IVD re-compression. However, our data suggests that significant IVD expansion may also occur during axial unloading beyond the thoracolumbar region in addition to spinal curvature modification . Thus, MRI studies are planned to determine the effect of axial unloading and reloading on total spinal length, IVD heights and spinal curvature.